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Case Docket No. **199-1255**  
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Transmitted herewith for filing is the patent application of Inventor(s):

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**Devang Desai**

For: **METHOD OF INTEGRATING PRODUCT INFORMATION MANAGEMENT WITH VEHICLE DESIGN**

Enclosed are:

- ☒ 4 sheet(s) of drawings
- ☒ Assignment and Cover Sheet
- ☒ Information Disclosure Statement, PTO Form 1449, and Copies of Citations
- ☐ A certified copy of

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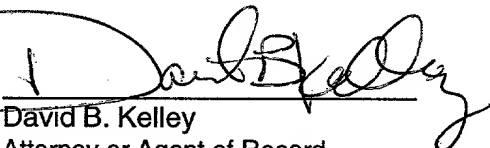
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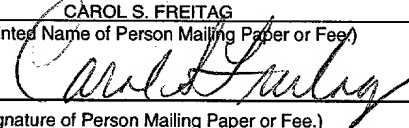
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## 10

## 1. Field of the Invention

## 2. Description of the Related Art

Vehicle design, and in particular automotive vehicle design, is a complex process relying on the talents of individuals with specific skills. Vehicle design involves several overlapping phases, including design initiation, development, assessment and verification. Each of these phases relies on information in order to make a decision regarding the design. The information pertinent to the design of a vehicle may be available in various forms, such as individual knowledge based on previous experience. Other forms include newly generated data, or existing data stored within a computer database. For a system as complex as a vehicle, information may be stored in multiple computer databases. Frequently,

the various computer databases are unrelated or maintained in incompatible formats. Access to and utilization of each of the databases by a user may require specialized knowledge or training, or  
5 multiple log-ins to access each database. Furthermore, a user may be unaware of the various databases and of the type of information available therein, to assist in the decision making process.

Information management provides for the  
10 systematic organization and delivery of information from various sources in a useful manner, to assist in decision making. In this example, information management is used in the design of a product, namely a vehicle. In the past, information delivery included  
15 the modification of the available information to suit the needs of the user, or to provide expert help to provide the information to the user in a useful manner. Information management has also focused on developing common naming conventions, processes and  
20 architectures to facilitate a systematic organization of information and cross-organization information transfer. Advantageously, access to the right information at the right time in the right format and with the right content can improve the quality and  
25 efficiency of a process, such as the vehicle design process. Thus, there is a need in the art for a

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method of integrating a product information management system with a vehicle design process to provide the user with centralized access to information in a predetermined manner to assist in  
5 informed decision-making.

#### SUMMARY OF THE INVENTION

Accordingly, the present invention is a method of integrating product information management  
10 with vehicle design. The method includes the steps of selecting a vehicle program requirement from a library stored in a memory of a computer system, wherein the library is accessed through an information portal on the computer system. The  
15 method also includes the steps of selecting an information database containing information related to the design of the vehicle from the library, wherein the information database is accessed through the information portal, and determining if the  
20 information from the information database correlates with the program requirement. The method further includes the steps of using the information from the information database in the design of the vehicle, if the information from the information database  
25 correlates with the program requirement.

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One advantage of the present invention is that a method of integrating product information management with vehicle design is provided that links together various existing databases, system  
5 infrastructure and information sources to provide a user with access to information contained therein to assist the user in informed decision making. Another advantage of the present invention is that the method uses an information portal approach to provide a user  
10 with access to information in its original format and content. Still another advantage of the present invention is that the method provides for customization of the information portal by the user for a specific process. A further advantage of the  
15 present invention is that the method utilizes a process driven approach to supply information within an information portal window.

Other features and advantages of the present invention will be readily appreciated, as the  
20 same becomes better understood, after reading the subsequent description taken in conjunction with the accompanying drawings.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

25 FIG. 1 is a block diagram of a system which may be utilized with a method of integrating product

information management with vehicle design, according to the present invention.

FIG. 2 is a perspective view of a vehicle.

FIG. 3 is a flowchart of a method of  
5 integrating product information management with vehicle design, according to the present invention, for the vehicle of Fig. 2.

FIG. 4 is a flowchart of another embodiment of a method of integrating product information  
10 management with vehicle design, according to the present invention.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Vehicle design is achieved according to the  
15 present invention with a generic parametric driven design process. Advantageously, this process allows flexibility in vehicle design and engineering analysis of the vehicle design in a fraction of the time required using conventional design methods.  
20 Various computer-based tools are integrated to achieve this enormous time and expense savings, including solid modeling, parametric design, automated studies and a knowledge-based engineering library.

25 Referring to the drawings and in particular FIG. 1, the tools 100 used by a method of integrating

product information management with vehicle design, according to the present invention, are illustrated graphically. The tools 100 include a knowledge-based engineering library 112 stored on an electronic storage device (not shown) that is operatively connected to a computer system 122 to be described. The knowledge-based engineering library 112 is a database of sub-libraries containing an electronic representation of data including various experts' knowledge of information relevant to the design of a vehicle 10 to be described. The knowledge-based engineering library 112 may include information such as design, assembly and manufacturing rules and guidelines. The knowledge-based engineering library 112 may also contain data in electronic form regarding various types of vehicle subsystems. The knowledge-based engineering library 112 may further contain predetermined product assumptions regarding the vehicle 10 to be designed, such as model year, style, or production volume.

The knowledge-based engineering library 112 may include a sub-library, such as a component parts library of particular component parts used on a vehicle. The component parts sub-library may contain information such as a parametric solid model of a particular component part, as well as parameters

Figure 1 consists of 12 histograms arranged in a single column. Each histogram represents the distribution of the number of non-zero elements in the vector  $x$  for a specific value of  $n$ . The x-axis for all histograms is labeled 'Number of non-zero elements' and ranges from 0 to 120. The y-axis is labeled 'Frequency' and ranges from 0 to 100. The histograms are labeled with  $n$  values: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, and 120. As  $n$  increases, the distribution of non-zero elements shifts to the right, indicating that the vector  $x$  contains more non-zero elements as  $n$  increases.

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5 generally known to those skilled in the art.

10 particular dimension or parameter is modified, the  
computer system 122 is instructed to regenerate a new  
vehicle or component part geometry.

15 One example of a CAE analysis tool 118 is  
computational fluid dynamics (CFD). Another example  
of a CAE analysis tool 118 is finite element analysis  
(FEA). Still another example of a CAE analysis tool  
118 is an ergonomic study. Several software programs  
20 are commercially available to perform these analyses  
and are generally known to those skilled in the art.

25 described, of integrating product information  
management with vehicle design. The computer system

122 includes a processor and a memory 124a, which can provide a display of information for the design of a system, such as the vehicle 10, on a display device such as a video terminal 124b.

5           In this example, the information is displayed on the video terminal 124b in a series of screens, also referred to as a browser. Selection and control of the information within a screen can be achieved by the user 126, via a user interactive  
10 device 124c, such as a keyboard or a mouse. The user 126 inputs a set of parameters or a set of instructions into the computer system 122 when prompted to do so. The set of parameters or the set of instructions may be product specific, wherein  
15 other data and instructions non-specific to the product may already be stored in the memory 124a.

One example of an input method is a pop-up screen containing available information or instructions, including an on-line description for  
20 the parameter and a current value therefore. For example, information may be chosen from a table within a two-dimensional mode.

The computer system 122 utilizes the set of information or instructions from the user 126, and  
25 any other information regarding related vehicle systems and information from the libraries 112, 114,

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design tools 116 and analysis tools 118, for a method 120, according to the present invention discussed in detail subsequently, of providing information to users that enhances informed decision making in the design of the vehicle 10.

Advantageously, the computer implemented method of integrating product information management with vehicle design, to be described, combines all of the foregoing to provide an efficient, flexible, rapid tool for making an informed decision regarding the design of the vehicle 10. Further, an informed decision regarding the vehicle design 128 is an output of the method 120 and the vehicle design 128 is available for further analysis and study.

Referring to FIG. 2, a vehicle 10, and in particular an automotive vehicle, is illustrated. The vehicle 10 includes a vehicle frame, generally indicated at 12, which supports a vehicle body 16. The vehicle 10 also includes a front axle (not shown) and rear axle (not shown) disposed in a spaced relationship to one another and extending substantially transverse to a longitudinal axis of the vehicle 10. It should be appreciated that wheels 14, as is known in the art, are operatively mounted to the front axle and rear axle, for rolling engagement with a surface such as a road.

15           The vehicle body 16 defines a front storage  
compartment 24 referred to as the engine compartment,  
which forms the general shape of the front of the  
vehicle 10.   The engine compartment   houses the  
powertrain system (not shown) for the vehicle 10. The  
20   vehicle   body   16   further   defines   an   occupant  
compartment 26 to accommodate vehicle occupants (not  
shown). The occupant compartment 26 includes a number  
of seats (not shown) for the occupants and control  
mechanisms (not shown) to operate the vehicle 10. The  
25   vehicle   body   16   also   defines   a   rear   storage

compartment 28, as is known in the art, forming the shape of the rear of the vehicle 10.

The vehicle 10 includes a powertrain system that propels the vehicle 10. The vehicle 10 includes  
5 a heat engine (not shown) operatively coupled to a transmission (not shown), as is known in the art. The transmission transmits engine rotation and power to a drive wheel 14. The transmission enables the vehicle 10 to accelerate over its speed range through  
10 predetermined gear ratios, while the engine functions within a predetermined operating range. It should be appreciated that the engine and transmission are in communication with a powertrain controller (not shown) that manages and controls their operation.  
15 Preferably, the vehicle 10 includes other systems such as a thermal management system (not shown), or a chassis system (not shown), which is conventional and well known in the art to operate the vehicle 10.

Referring to FIG. 3, flowchart of a method,  
20 according to the present invention, of integrating product information management with vehicle design is illustrated. Advantageously, product information management makes data and information from a variety of sources available through a common source, and  
25 provides for delivery of the information to the user 126 for use in critical product decision making.

The methodology begins in bubble 200 and advances to block 205. Advantageously, the method utilizes a web-enabled portal process to provide the user 126 with information in its original format and content to use in the design of the vehicle 10. As is known in the art, an information portal is a web site that provides a particular audience with access to diverse sets of information organized in a specific manner. It should be appreciated that the information portal may contain a series of screens that leads the user 126 step by step through a decision making process and provides the appropriate information to the user 126 at the right time. The user 126 can be linked with other experts through an information portal screen to assist in the underlying engineering process. In this example, the information portal is organized into screens that provide the user 126 with information to make an informed decision relating to the vehicle design 128 of the vehicle 10. Examples of the type of information relevant to vehicle design 128 include warranty, product design data and manufacturing data. Advantageously, the method utilizes a web-based portal process to provide the user 126 with information in its original format and content to use in the vehicle design 128 of the vehicle 10.

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Advantageously, the information portal can also be customized for a particular user 126. For example, different users 126 may utilize the same information databases within the knowledge-based  
5 engineering library 112, but at different stages within the vehicle design process. If a user 126 repeatedly performs a set of operations, a macro-type customization, as is known in the art, can be developed and the information portal can be  
10 personalized to present only the resulting information, in order to improve data processing and overall business efficiency.

In block 205, the user 126 determines specific program requirements related to the vehicle  
15 design 128 of the vehicle 10 and selects an information database for decision making purposes from an information portal displayed on the video terminal 124b. An example of a program requirement is information maintained within the knowledge-based  
20 library 112 regarding the type of vehicle 10 to be designed, such as passenger car or truck. Another example of a program requirement is anticipated production volume, or vehicle body style. Still another example of a program requirement is a  
25 warranty target. Advantageously, the user 126 may select a program requirement from an information

portal screen displayed on the display terminal 124b containing a list of program requirements. The user 126 may also select an information database related to making an informed decision regarding the vehicle design 128 of the vehicle 10 from the information portal screen. The information database is a compilation of existing information maintained within a database in the knowledge-based engineering library 112. For example, the information may be existing data from a previously conducted vehicle test procedure. The methodology advances to diamond 210.

In diamond 210, the methodology determines if the information from the information database correlates with the program requirements. For example, the information may be compared to the program requirements to determine if there is a change in a component part that would affect the use of the information in making an informed decision regarding the vehicle design 128. The information may also be compared to the program requirements to determine if there is a design or manufacturing process change that would affect the use of the information. The information may further be compared to the program requirements to determine if there is a field issue or a change in customer expectation that would affect its use. If the information does



In block 215, the methodology uses the information from the information database in making an informed decision regarding the design of the vehicle 10. The methodology advances to block 250, to be described. Returning to block 210, if the information does not correlate with the program requirements, the methodology advances to block 220.

In diamond 225, the user 126 determines if a portion of the information from the information database correlates with the program requirements in light of the additional information available through the information portal screen. For example, the user

126 may access a database to review conditions under which the information was generated to determine if a portion of the information correlates with the program requirements. The user 126 may also access a  
5 database to determine if criteria exist to determine if a portion of the information will correlate with the specific program requirements. If a portion of the information will correlate with the specific program requirements, the methodology advances to  
10 block 230. In block 230, the user 126 uses the portion of the information from the information database that satisfies the specific program requirements for informed decision-making regarding the vehicle design 128 of the vehicle 10. The  
15 methodology advances to bubble 250, to be described.

Returning to diamond 225, if the portion of the information does not satisfy the predetermined requirements in light of the additional information, the methodology advances to block 235. In block 235,  
20 the user 126 determines through the information portal if still more information is available from still another database within the knowledge-based engineering library 112 to assist in determining if a portion of the information from the information  
25 database correlates with the program requirements. The methodology advances to diamond 240.

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In diamond 240, the user 126 determines through the additional information displayed on the information portal whether to generate new information pertaining to the vehicle design 128 of the vehicle 10 based on the available additional information. For example, the user 126 may decide to perform a task such as a laboratory test, since existing test information or a portion thereof is not reusable. If the user 126 decides to generate new information, the methodology advances to block 245. In block 245, the user 126 generates new information. For example, the user 126 may decide whether to perform a test on either an actual vehicle or in a laboratory. The methodology advances to bubble 250 and ends. Returning to diamond 240, if the user 126 determines not to generate new information, the methodology advances to bubble 250 and ends.

Referring to FIG. 4, another embodiment, according to the present invention, of a method of integrating product information management with vehicle design is illustrated. In this embodiment, the method is utilized for making a decision regarding existing verified information, for use in the vehicle design 128 of the vehicle 10. Advantageously, an information verification process determines if previously verified information or data

can be reused in the current vehicle design, to save time and cost and improve product quality. An example of previously verified data is vehicle test data. The method begins in bubble 300 and continues to block  
5 305.

In block 305, the user 126 determines through an information portal screen displayed on the video terminal 124b, specific program requirements maintained in the knowledge-based engineering library  
10 112 that are applicable to the vehicle design 128 of the vehicle 10. An example of a program specific durability target for a component part is 200,000 miles. In this example, selecting a durability guideline program requirement from the information  
15 portal screen will access a durability guideline maintained in a knowledge-based engineering library 112. The user 126 also uses the information portal screen to select an information database from the knowledge-based engineering library 112 that is  
20 related to the vehicle design 128 of the vehicle 10. In this example, the information database is a durability information database containing verified durability test data. The methodology advances to block 310.

25 In diamond 310, the user 126 determines through the information portal screen if the existing

5 requirements, the methodology advances to block 315.

10 requirements. The methodology advances to bubble 380  
and ends.

15 advances to block 320. In block 320, the user 126  
determines through the information portal screen if  
additional information is available that may  
influence the reuse of existing durability  
information in the verification process. For example,  
20 the user 126 may locate a durability target for a  
subsystem of the vehicle 10. The methodology  
advances to diamond 325.

25 existing durability information may be reused based  
on the additional information. If a portion of the

durability information may not be reused, the methodology advances to block 330. In block 330, the user 126 generates new information. For example, the user 126 may perform a test to generate new data for use in the vehicle design 128 of the vehicle 10. The methodology advances to block 335 and the user 126, through the information portal screen, selects the type of test to be performed to generate new data. One example of a test is an evaluation in a laboratory using a test stand. Another example of a test is an on-road evaluation using a vehicle 10. The methodology advances to block 340.

In block 340, the selected test is performed to generate new data. The methodology advances to block 345. In block 345, the methodology uses the newly generated information in the vehicle design 128 of the vehicle 10. The methodology advances to bubble 380 and ends.

Returning to diamond 325, if a portion of the information does satisfy a predetermined requirement, the methodology advances to diamond 350. In diamond 350, the user 126 determines through the information provided through the information portal if conditions are known under which the existing durability data was generated. Advantageously, additional information from still another information

5 diamond 330 and continues.

15 the degree of confidence does meet the predetermined  
criteria, the methodology advances to block 315 and  
continues. Returning to diamond 355, if the degree  
of confidence does not meet the predetermined  
criteria, the user 126 advances to block 365. In  
20 block 365, the user 126 performs a test such as a  
computer-aided engineering analysis 118 to verify the  
use of the reuse data. The methodology advances to  
block 370.

25 through still more information in the information  
portal if confidence in the results of the CAE

analysis 118 meets a predetermined criteria. If confidence in the results of the CAE analysis 118 does not meet a predetermined criteria, the methodology advances to diamond 330 and continues.

5 Returning to diamond 370, if confidence in the results of the CAE analysis 118 does meet a predetermined criteria, the methodology advances to block 375. In block 375, the methodology uses the results of the CAE analysis 118 and a portion of the

10 verification information in informed decision-making regarding the vehicle design 128 of the vehicle 10. The methodology advances to bubble 380 and ends.

The present invention has been described in an illustrative manner. It is to be understood that

15 the terminology, which has been used, is intended to be in the nature of words of description rather than of limitation.

Many modifications and variations of the present invention are possible in light of the above

20 teachings. Therefore, within the scope of the appended claims, the present invention may be practiced other than as specifically described.



**WHAT IS CLAIMED IS:**

1. A method of integrating product information management with vehicle design, said method comprising the steps of

5 selecting a vehicle program requirement from a library stored in a memory of a computer system, wherein the library is accessed through an information portal on the computer system;

10 selecting an information database containing information related to the design of the vehicle from the library, wherein the information database is accessed through the information portal;

15 determining if the information from the information database correlates with the program requirement; and

using the information from the information database in the design of the vehicle, if the information from the information database correlates with the program requirement.

20

2. A method as set forth in claim 1 including the step of selecting through the information portal additional information for determining if the information from the information  
25 database correlates with the program requirement, if

the information from the information database does not correlate with the program requirement.

3. A method as set forth in claim 2  
5 including the step of determining if a portion of the information from the information database correlates with the program requirement based on the additional information.

10 4. A method as set forth in claim 3 including the step of using the portion of the information from the information database that correlates with the program requirement in the design of the vehicle, if a portion of the information from  
15 the information database correlates with the program requirement.

5. A method as set forth in claim 4  
including the step of selecting through the  
20 information portal additional information regarding the design of the vehicle.

6. A method as set forth in claim 5  
including the step of using the additional  
25 information to determine whether to generate new information for use in the design of the vehicle and

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the information database does not correlate with the program requirement;

determining if a portion of the information from the information database correlates with the program requirement based on the additional information; and

using the portion of the information from the information database that correlates with the program requirement in the design of the vehicle.

10

8. A method as set forth in claim 7 including the step of selecting through the information portal additional information regarding the design of the vehicle.

15

9. A method as set forth in claim 8 including the step of using the additional information to determine whether to generate new information for use in the design of the vehicle and generating new information if determined that the new information should be generated.

10. A method of integrating product information management with vehicle design to verify existing information, using a computer system having

a memory, a display device and a user interactive device, said method comprising the steps of:

selecting a vehicle program requirement for the design of the vehicle from a library stored in a memory of the computer system, wherein the library is  
5 access through a web-based information portal displayed on the display device;

selecting an information database of verification information for the design of the  
10 vehicle, wherein the information database is accessed through the information portal;

determining if the verification information from the information database correlates with the program requirement;

15 using the information database in the design of the vehicle if the verification information correlates with the program requirement;

selecting through the information portal additional information regarding the design of the  
20 vehicle;

using the additional information to determine if a portion of the verification information correlates with the program requirement;

using the portion of the verification  
25 information that correlates with the program requirement if determined that a portion of the

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verification information correlates with the program requirement; and

generating new information if a portion of the verification information does not correlate with  
5 the program requirement.

11. A method as set forth in claim 10 including the step of determining through the information portal if a condition is known by which  
10 the verification information was generated, if a portion of the verification information correlates with the program requirement.

12. A method as set forth in claim 11  
15 including the step of generating new verification information if the condition by which the verification information was generated is not known and using the new verification information in the design of the vehicle.

20

13. A method as set forth in claim 11 including the step of determining confidence in the portion of the verification information that correlates with the program requirement if the  
25 condition by which the verification information is generated is known.

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14. A method as set forth in claim 13  
including the step of performing a computer-aided  
engineering analysis of the verification information  
5 if not confident in the verification information.

15. A method as set forth in claim 14  
including the step of using the portion of the  
verification information and the results of the  
10 computer-aided engineering analysis in the design of  
the vehicle if confident in the computer-aided  
engineering analysis.

16. A method as set forth in claim 13  
15 including the step of using the portion of the  
verification information in the design of the vehicle  
if confident in the verification information.

**METHOD OF INTEGRATING PRODUCT INFORMATION MANAGEMENT  
WITH VEHICLE DESIGN**

**5                    ABSTRACT OF THE DISCLOSURE**

A method of integrating product information management with vehicle design includes the steps of selecting a vehicle program requirement from a library stored in a memory of a computer system, 10 wherein the library is accessed through an information portal on the computer system. The method also includes the steps of selecting an information database containing information related to the design of the vehicle from the library, 15 wherein the information database is accessed through the information portal, and determining if the information from the information database correlates with the program requirement. The method further includes the steps of using the information from the 20 information database in the design of the vehicle, if the information from the information database correlates with the program requirement.

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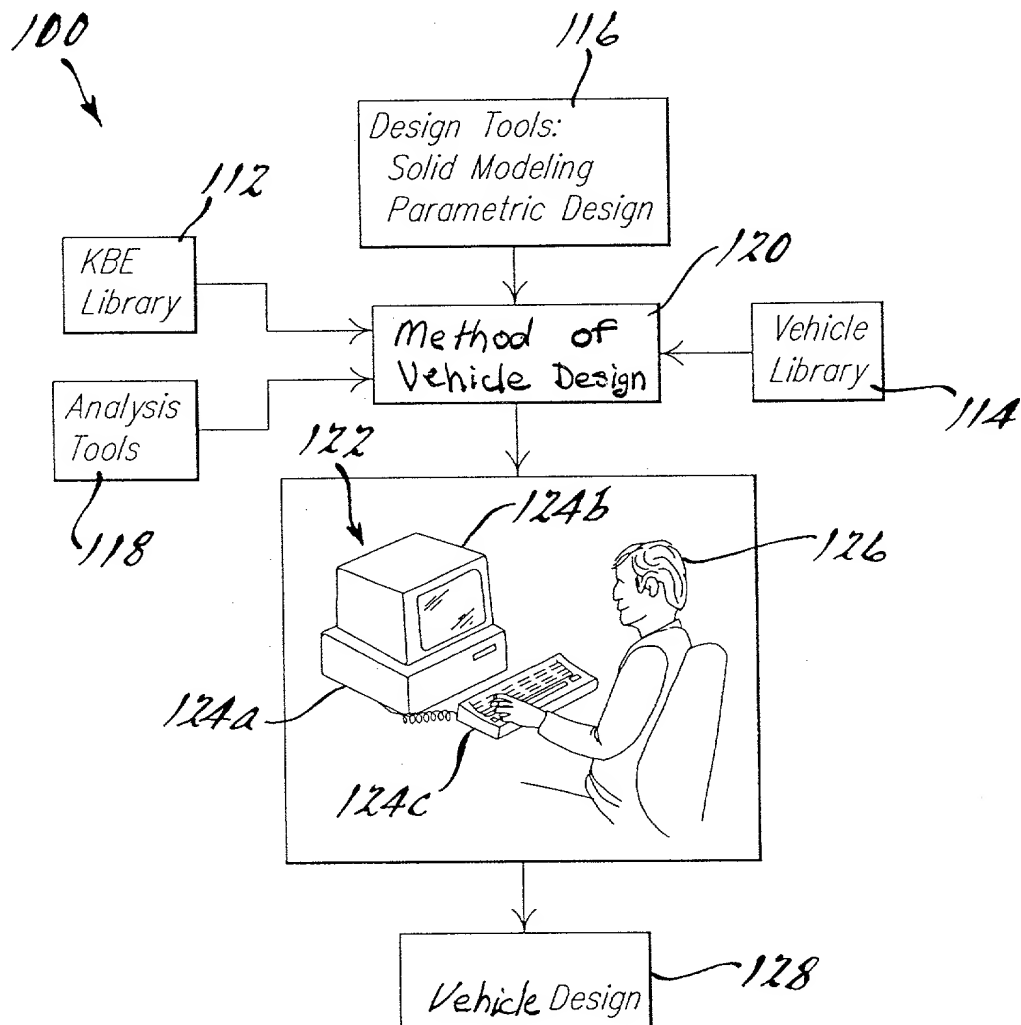
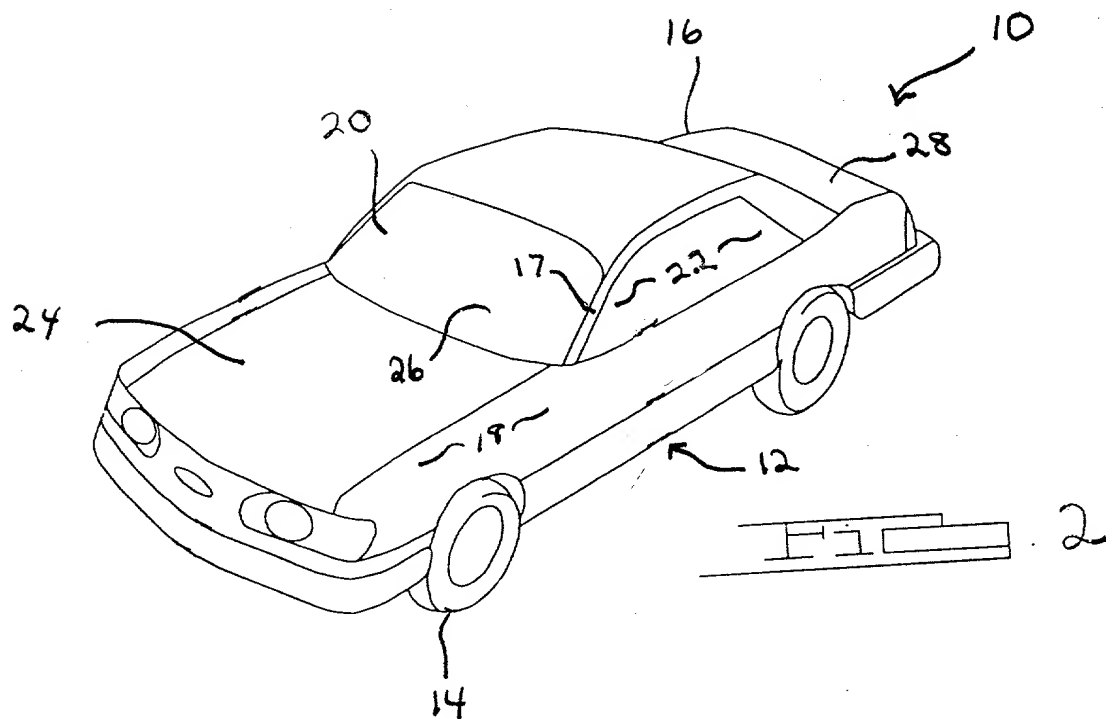


FIG. 1.

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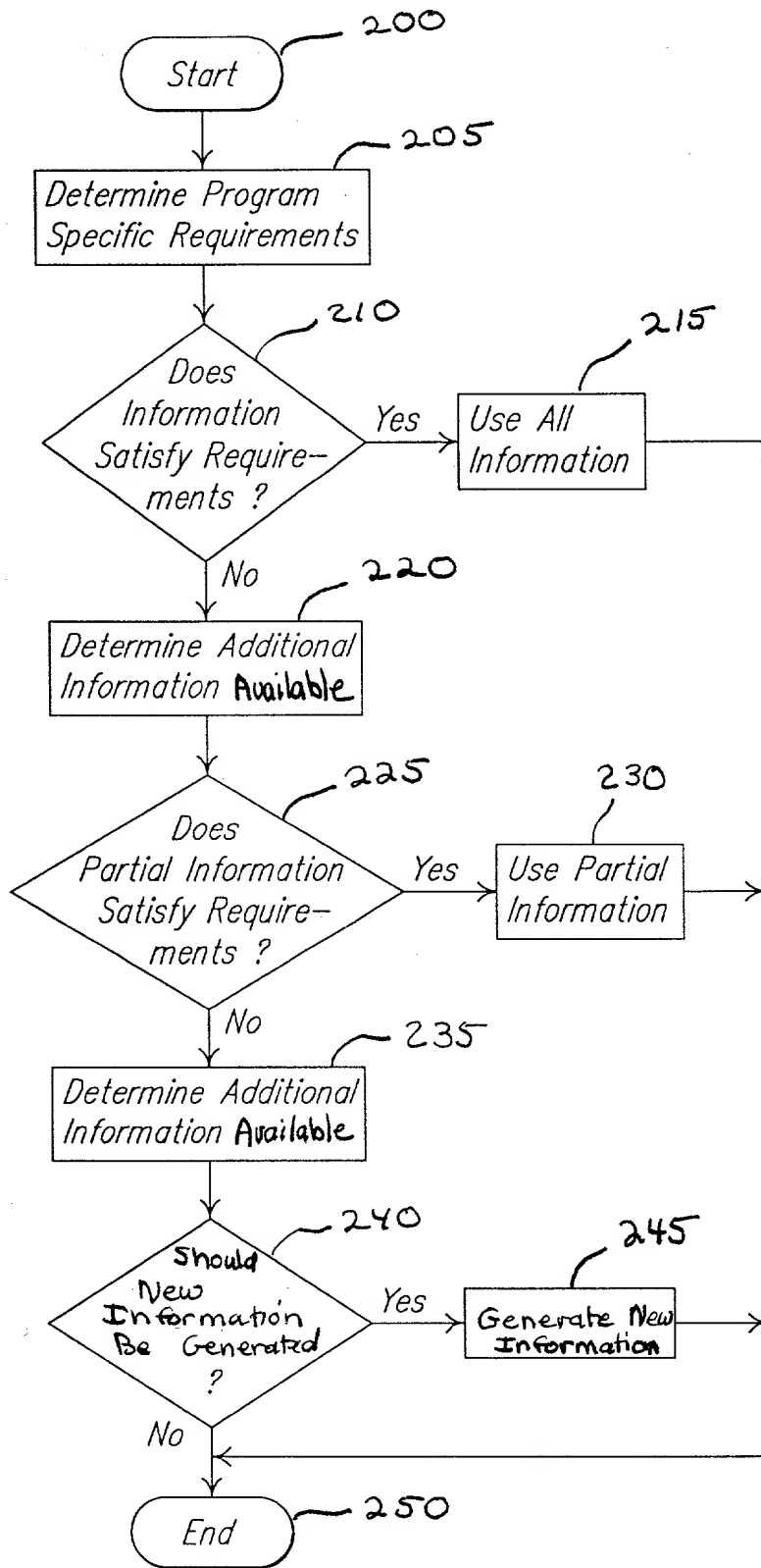
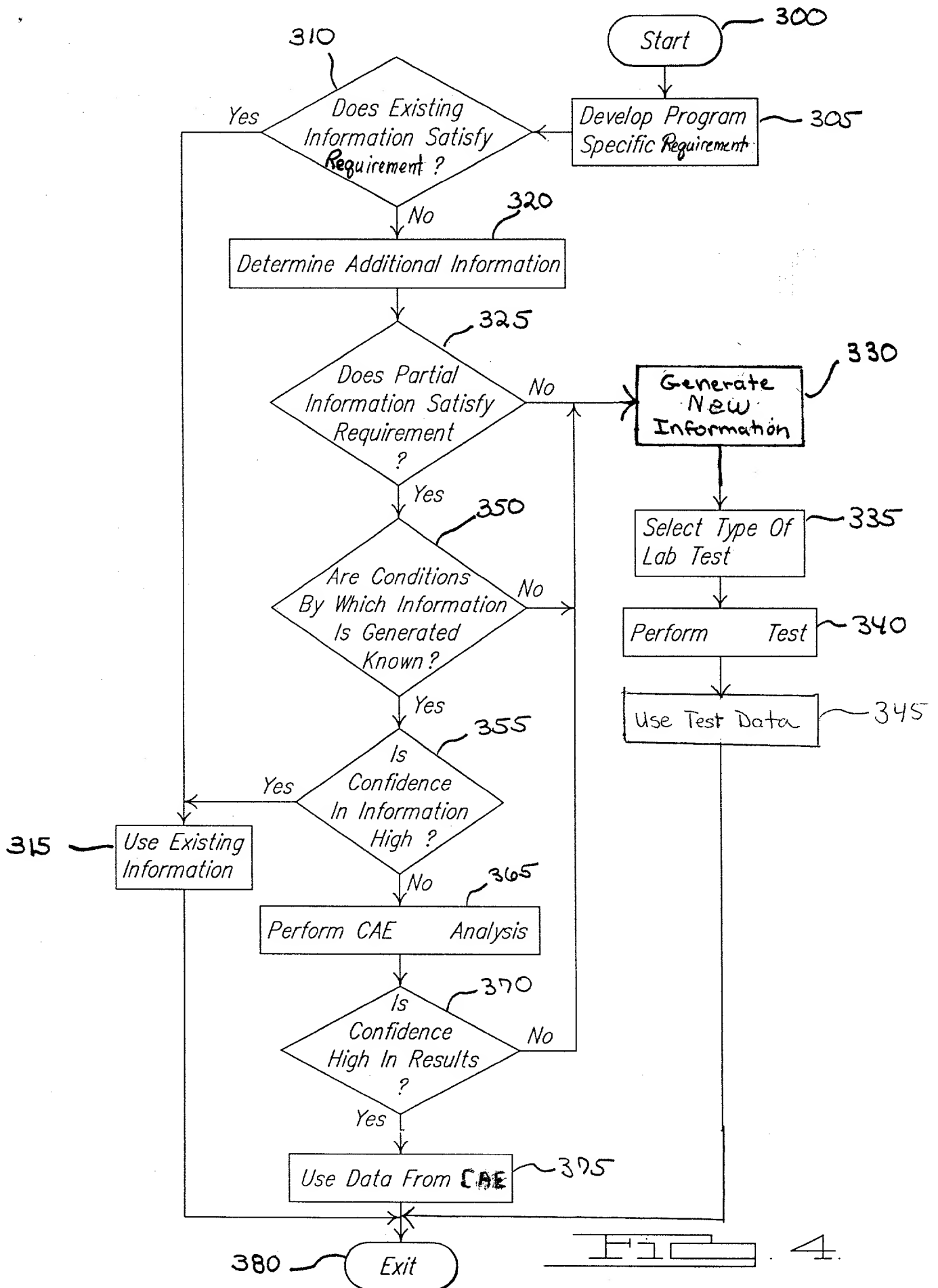


FIG. 3.

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**Attorney's Docket No.**  
**199-1255**

My residence, post office address and citizenship are as stated below next to my name;

I verily believe I am the original, first and sole inventor or an original, first and joint inventor of the subject matter that is claimed and for which a patent is sought on the invention entitled

## METHOD OF INTEGRATING PRODUCT INFORMATION MANAGEMENT WITH VEHICLE DESIGN

the specification of which is attached hereto.

I have reviewed and understand the contents of the specification identified above, including the claims.

I acknowledge my duty to disclose information of which I am aware that is material to the examination of this application in accordance with Section 1.56(a), Title 37 of the Code of Federal Regulations; and

as to application for patents or inventor's certificate on the invention filed in any country foreign to the United States of America, prior to this application by me or my legal representatives or assigns,

☒ no such applications have been filed, or

☐ such applications have been filed as follows

| COUNTRY | APPLICATION NO. | DATE OF FILING<br>(day, month, year) | DATE OF ISSUE<br>(day, month, year) | PRIORITY CLAIMED<br>UNDER 35 USC 119 |
|---------|-----------------|--------------------------------------|-------------------------------------|--------------------------------------|
|         |                 |                                      |                                     |                                      |
|         |                 |                                      |                                     |                                      |

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s) or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

| (Application Number) | (Filing Date) | (Status - patented, pending, abandoned) |
|----------------------|---------------|---|
|----------------------|---------------|---|

| (Application Number) | (Filing Date) | (Status - patented, pending, abandoned) |
|----------------------|---------------|---|
|----------------------|---------------|---|

**POWER OF ATTORNEY:** As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the United States Patent and Trademark Office connected therewith and to act on my behalf before the competent International Authorities in connection with any and all international applications filed by me.  
(List name and registration number)

**Daniel H. Bliss - 32,398**  
**David B. Kelley - 33,718**  
**Roger L. May - 26,406**

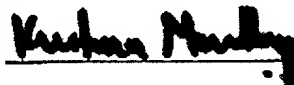


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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

| NAME AND POST OFFICE ADDRESS<br>OF INVENTOR:                            | RESIDENCE                        | CITIZENSHIP | SIGNATURE   | DATE     |
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| Krishna Murthy<br>28696 Roxbury<br>Farmington Hills, MI 48331 US        | Farmington Hills, MI 48331<br>US | U.S.A       |  | 3/27/00  |
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